VATECH

VA TECH HYDRO

TURBINES & GENERATORS

Water. Power. Large.

Hydro

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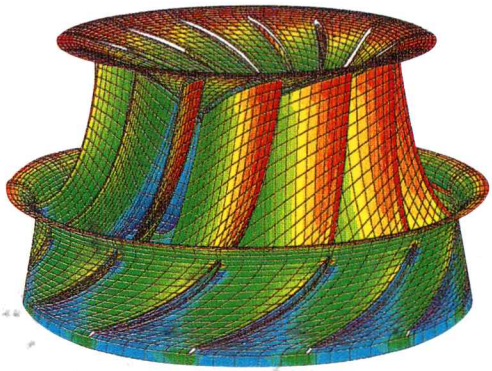
ESCHER WYSS VOEST MCE ELIN SAT AUTOMATION

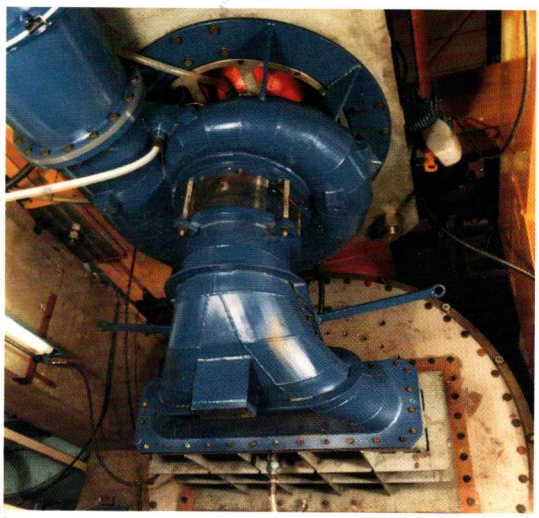
RESEARCH AS A DRIVING FORCE

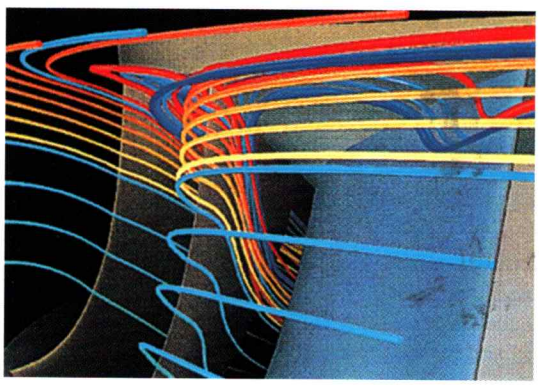
Top performance

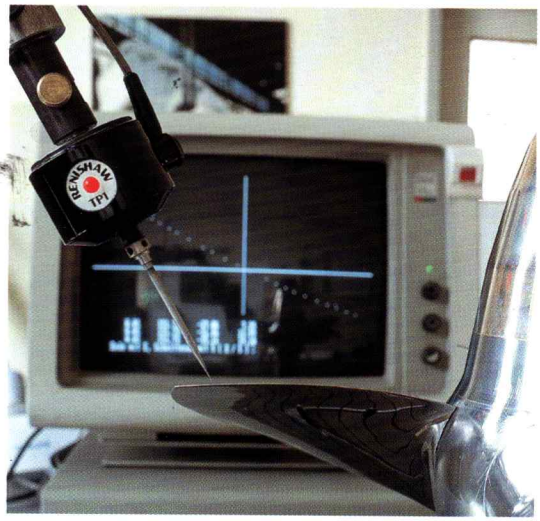
VA TECH HYDRO is one of the world's largest suppliers in the hydropower generation market and can draw on more than 160 years of experience and knowledge with over 225,000 MW installed capacity. Innovations as a form of converting ideas into marketable problem solutions have always been one of the most important strategic goals.

Numerical flow analysis (CFD) and hydraulic model testing ensure the top level performance of VA TECH HYDRO turbine types. This is done in the company's own hydraulic laboratories in Linz, Vevey and Zurich on a regular basis to keep the top position of our company's technology.





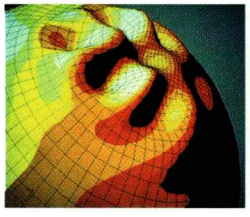




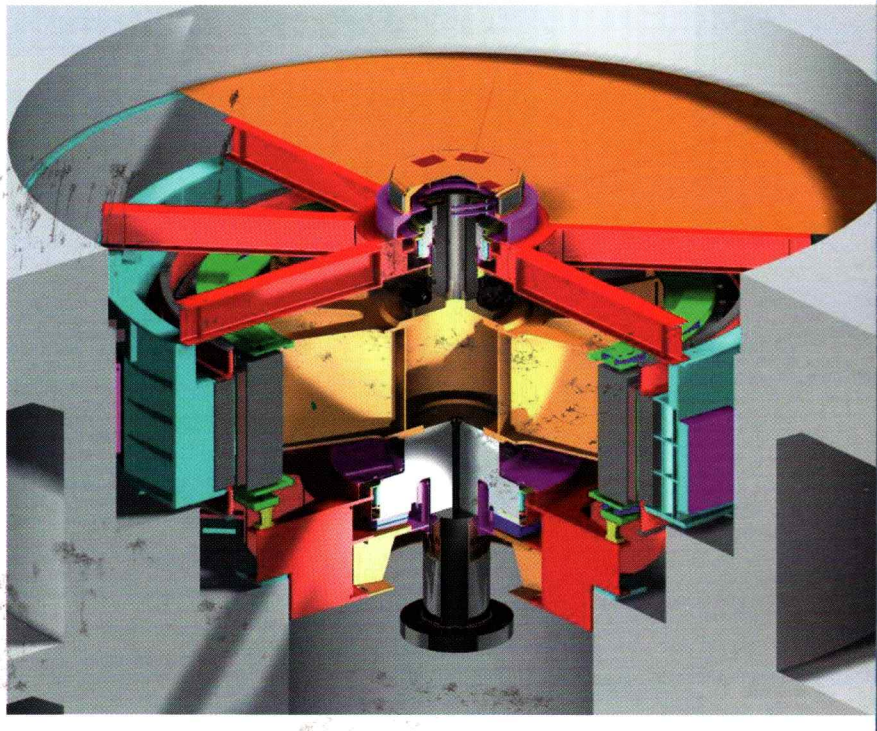
Reliability and safety

State of the art technology in the design and highly sophisticated methods of electro-mechanical calculations, focusing on detailed magnetic field investigations, guarantee the efficiency of our generators.

To calculate dynamic behaviour and thermal conditions of generators and to determine the stress and deflections of the machine, we use the Finite Element Analysis method



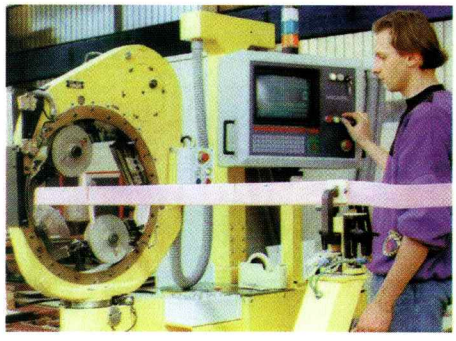
in conjunction with our advanced material and manufacturing technologies. For the detailed design of the components we use the 3D volume orientated CAD system UNIGRAPHICS which gives a realistic 3-dimensional view of all components in order to finally achieve a maintenance-friendly product that fulfills highest safety requirements.
Our vacuum-pressure impregnated VACUBAND™ high voltage insulation system is based on mica and top-quality epoxy resins and has significantly improved dielectric characteristics. As a result of using only self extinguishing, class F insulating material and permanent monitoring of the manufacturing process, our insulation system has excellent electrical, thermal and mechanical properties combined with outstanding life endurance performance.



VA TECH HYDRO developed a system for the permanent elastic embedding of high voltage windings in stator and rotor cores, EWB™ (Elastic Winding Beddings), using a highly conductive elastomer material with the following advantages:

- No more loose windings
- Free thermal expansion of stator windings acc. to load
- Excellent thermal and electrical conductivity between windings and core
- High heat resistance
- Permanent elasticity

Our EWB™ system can be applied in any mounting position and is equally suitable for refurbishment projects as well as for mounting windings in new equipment.



LOCATIONS AND WORKSHOPS

Headquarters/Locations

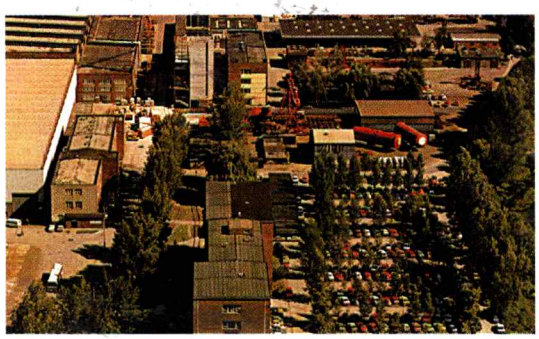
Vienna, Austria,
VA TECH HYDRO Headquarters

Today VA TECH HYDRO has its headquarters in Vienna/Austria and large manufacturing workshops in Ravensburg/Germany, Linz/Austria and Kriens/Switzerland for turbines. Additional manufacturing locations are Schio/Italy, Madrid/Spain, Morelia/Mexico and Faridabad/India.

Two large generator manufacturing work-shops are located in Weiz/Austria as well as in Bhopal/India.

Weiz, Austria

Ravensburg, Germany



Linz, Austria

Kriens, Switzerland

Bhopal, India

HIGHLIGHTS

The pioneers created the foundations:

1844 Supply of first water turbines of Jonval design

1851 Installation of first water turbine in USA near Philadelphia

1863 First water turbine in Switzerland

1892 First electric generator by Pichlerwerke in Weiz, Austria

1895 Order for ten Francisturbines at the Niagara Falls powerplant

1903 High pressure (390 m) Pelton turbine for Necaxa, Mexico

1923 First two-stage storage pump with adjustable wicket gates in Schwarzenbach, Germany

1926 First high capacity, vertical shaft Pelton turbine supplied for Big Creek, USA

1928 First large Kaplan turbine with a runner diameter of 7 m and an output of 30,000 kW for Schwoerstadt, Germany

1935 Design and supply of two vertical Francis turbines with an output of 115,000 HP for Boulder dam, USA. This is world record !

1936 First Bulb type Kaplan turbine with inside generator at Rostin, Poland

1937 First STRAFLO turbine in the world with outer rim generator at Iller VII, Germany

1958 First high head Francis turbine (522 m), output 72,000 kW at Ferrera, Switzerland

1960 Largest Kaplanturbine in the western world, runner diameter 8.4 m, and largest generator with a stator bore diameter of 11.6 m and 85 MVA, at Aschach, Austria

1967 Francis turbine with the highest head in the world, 672 m and 58.4 MW in Rosshaag, Austria

1970 Most powerful horizontal shaft Francis turbine (262 MW) installed at Hornberg, Germany

1976 Highest head for multistage pump-turbine (1,290 m) at Edolo, Italy

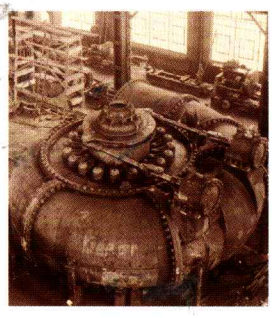
1978 Largest Bulb turbine/generator units in the world, runner diameter 7.7 m, bulb diameter 8.4 m at Racine, USA

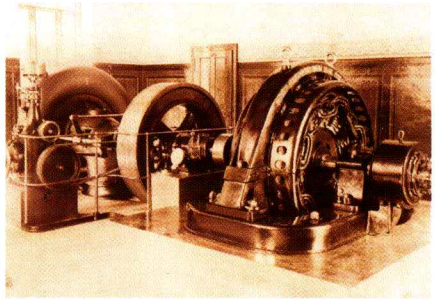
1981 Francis turbine with highest head (734 m), 180 MW installed at Haeusling, Austria

1994 World record Pelton turbines, (423 MW, 1,869 m) for Bieudron, Switzerland

1996 Largest Bulbtype generator (diameter 9 m) for Da Yuan Du in China

1998 Supply of two synchronous and two asynchronous motor-generators with variable speed for Goldisthal pumped storage plant in Germany

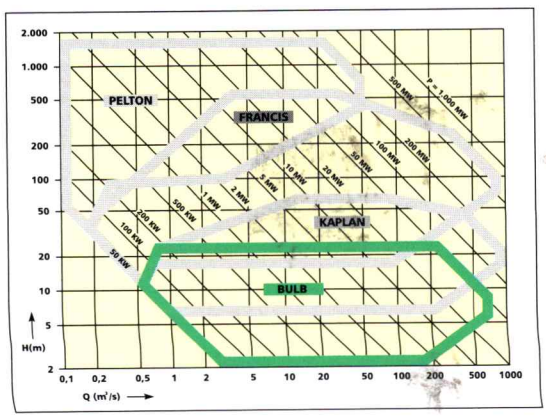




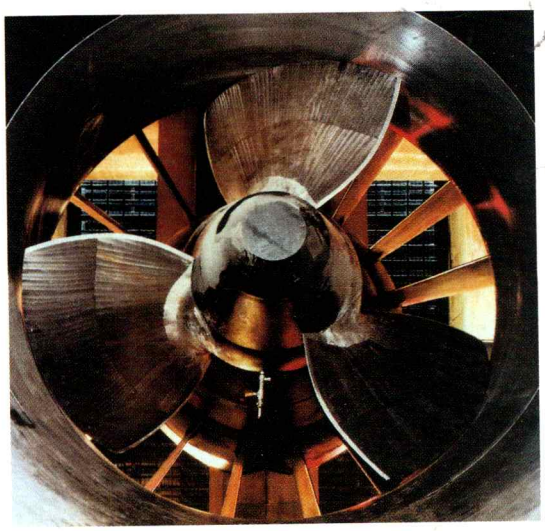
PIT AND BULB

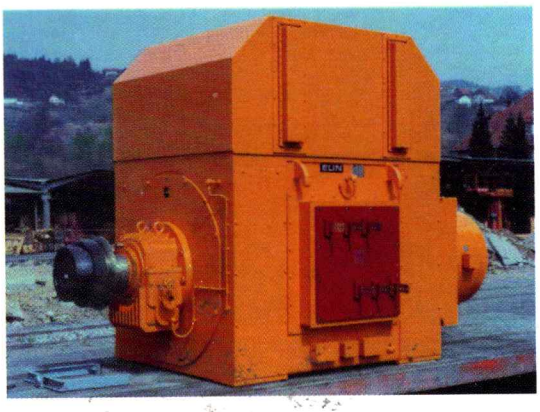
Optimized performance at lower head range

Today low heads can be used for power generation very economically feasible. More than 300 units supplied by VA TECH HYDRO from heads up to 30 m, a maximum runner diameter of 7,700 mm and outputs up to 55 MW are the experience in this segment of hydro power.



Arkansas 9 & 13, USA

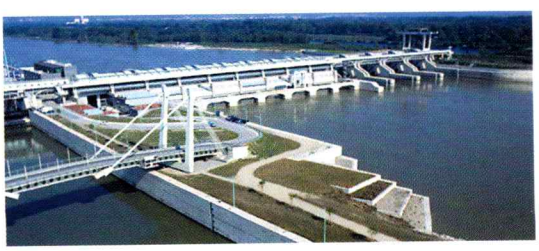




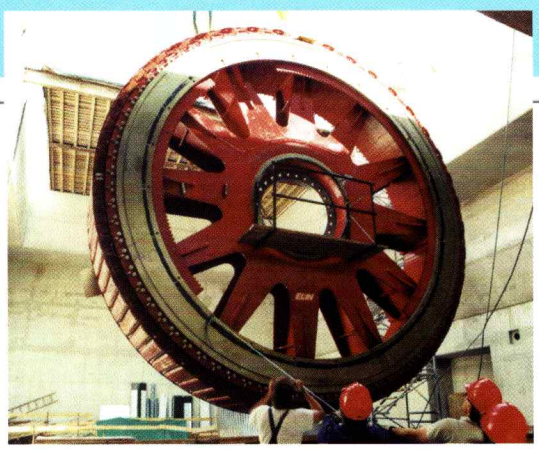
Located at Lock & Dam 9 and 13, VA TECH HYDRO has supplied 6 units for these two low head powerstations.The concept includes a planetary step up gear as a speed increaser for a small and cost-saving high speed generator. Electronic-hydraulic governors as well as hydraulic operated draft tube emergency gates were included in the scope of supply.

Technical data:	9 / 13	
Output:	3 x 11.2 / 11.2	MW
Head:	4.8 / 6.7	m
Speed:	77 / 900	rpm
Runner diameter:	5,800	mm

Freudenau, Austria



In 1992 a referendum on the construction of the Freudenau Hydropower plant was held in Vienna, which was supported by a majority of approximately 75%. Like all other Danube river hydropower plants,

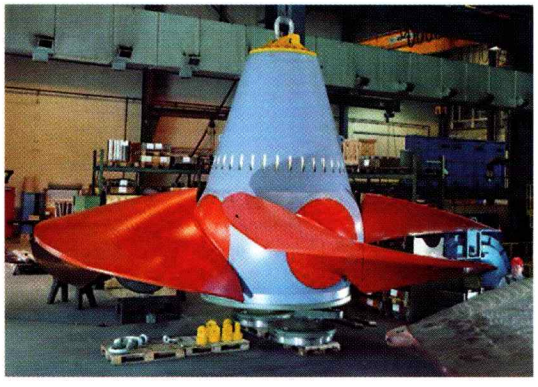


Freudenau, which is located within the municipal area of Vienna, is equipped with six VA TECH HYDRO Bulbturbine/Generator units.

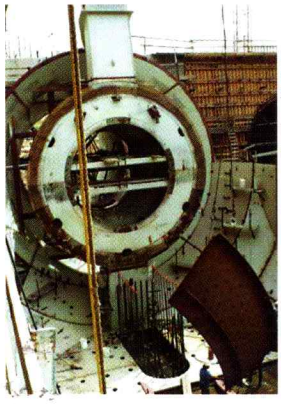
Technical data:		
Output:	6 x 30.3	MW
Head:	6.8	m
Speed:	65.2	rpm
Runner diameter:	7,500	mm

Arkansas 2, USA

The project site is located at the U.S. Army Corps of Engineer's Lock and Dam No. 2 the last on the Arkansas river just 20 miles before the junction with the Mississippi river. The power station with 3 large Bulb turbines of 108 MW total output and successfully commissioned in 1999 is the largest water power facility owned and established by Arkansas Electric Cooperatives Corporation (AECC). The turbines are capabale to operate over a wide flow and head range and are equipped with a self-regulating cathodic-protection system to protect the steel and stainless steel components against the salty, highly corrosive water.

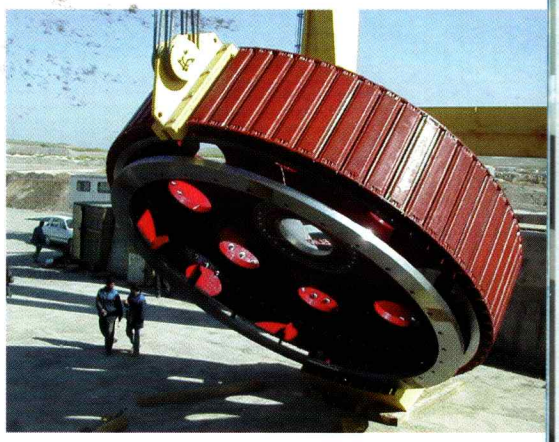


Technical data:		
Output:	3 x 35	MW
Head:	12	m
Speed:	72	rpm
Runner diameter:	7,000	mm



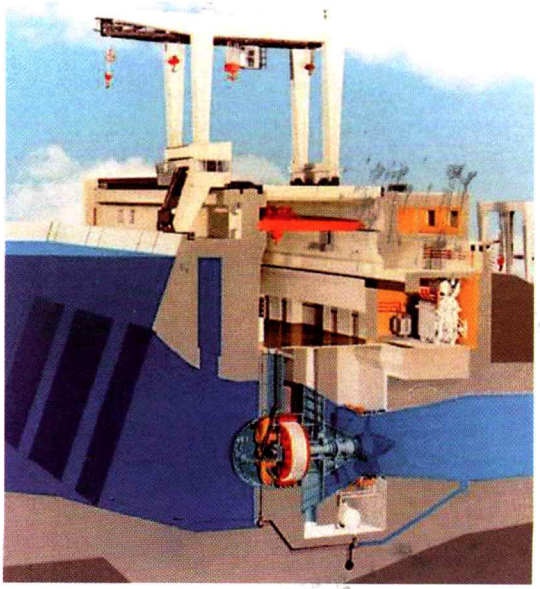
Karkamis, Turkey

In 1995 a consortium under the leadership of VA TECH HYDRO was awarded a Turnkey-contract for the 185 MW Bulb type power plant Karkamis. The plant is located at the river Euphrates in the southeastern part of Turkey, near the Syrian border. VA TECH HYDRO supplied the complete electrical equipment: six Bulb type generators, main- and station service transformers, LV-, MV- and HV switchgear, excitation, protection- and control-system, auxiliary systems on a Turnkey basis. The entire project was scheduled to be installed and commissioned within 48 months but finally after 47 months the last unit went into commercial operation in April 2000.



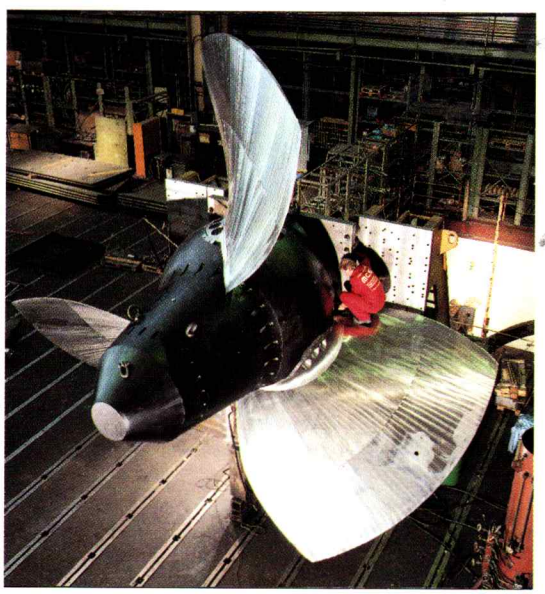
Technical data:		
Output:	6 x 34.8	MVA
Voltage:	9.0	kV
Speed:	88.2	rpm
Stator:	7,500	mm

BULB AND STRAFLO



Belleville, USA

With a runner diameter of 7,500 mm these two Bulb turbines supplied by VA TECH HYDRO are among the largest in the world. The power station is located on the Ohio river. The scope of supply includes two Bulb turbines together with digital type governors, direct coupled generators, static excitation, supervision of installation and commissioning. The supply contract was decided by international competitive bidding after careful evaluation of total price of equipment, energy generation and experience in the field of low head hydro power.

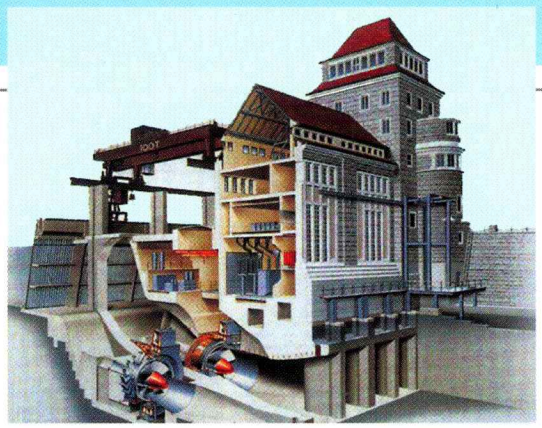


Technical data:		
Output:	2 x 25.9	MW
Head:	5.5	m
Speed:	64.3	rpm
Runner diameter:	7,500	mm

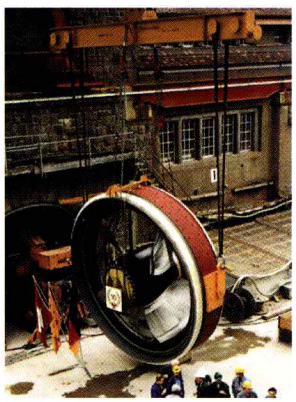
Laufenburg, Switzerland

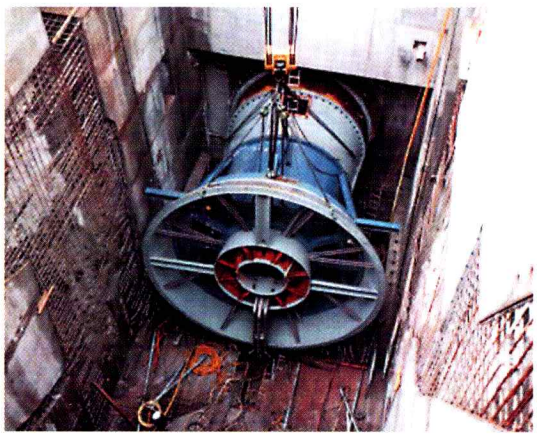
Built in the early years 1910-1914 with 10 horizontal Francis units having 4 runners per shaft to generate a power of 48 MW from the headwaters of the river Rhine, the Laufenburg power station has been completely modernized from 1988 to 1992.

The upgrading scheme comprised the replacement of all existing units by STRAFLO™ type turbines to bring the plant output to almost 108 MW.



The application of new STRAFLO™ units in replacement of old horizontal or vertical Francis units is a tremendously successful concept to overcome space limitations as well as minimizing power plant alterations without effecting or increasing investment costs. Consequently this concept has been repeated for several power plants including Augst (Switzerland) and Wyhlen (Germany).

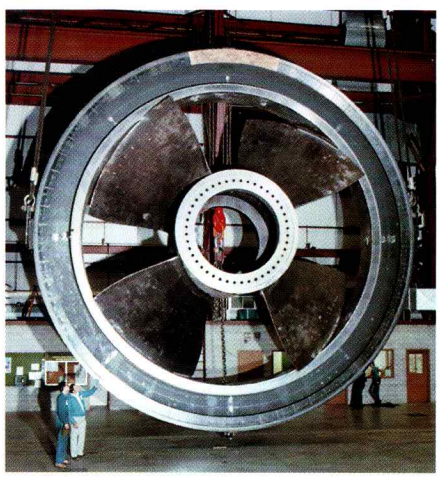




Technical data:		
Output:	10 x 11.6	MW
Head:	10	m
Speed:	107	rpm
Runner diameter:	4,250	mm

Annapolis, Canada

The Annapolis Royal Tidal plant featuring a STRAFLO™ turbine is installed at the Annapolis basin in the arm of the Bay of Fundy, in the province of Nova Scotia, Canada. The STRAFLO™ turbine was installed to harness the energy from tides of maximum 15.8 m. The STRAFLO™ unit comprises a combined turbine generator aggregate without driving shaft. The concept results in a very compact design of the unit. More than 110 STRAFLO™ units were produced by VA TECH HYDRO since 1938 worldwide. Latest STRAFLO™ unit was installed in the late 1990's at the Pointe du Bois G.S. in the province of Manitoba, Canada with outstanding performance results.

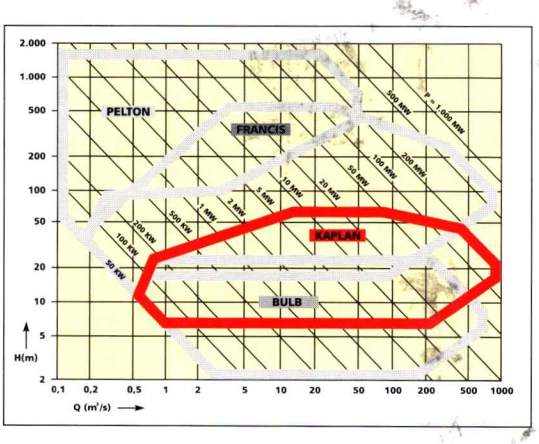


Technical data:			
Output:	21.3 MVA	19.9	MW
Head:		7.1	m
Speed:		50	rpm
Runner diameter:		7,600	mm

KAPLAN AND PROPELLER

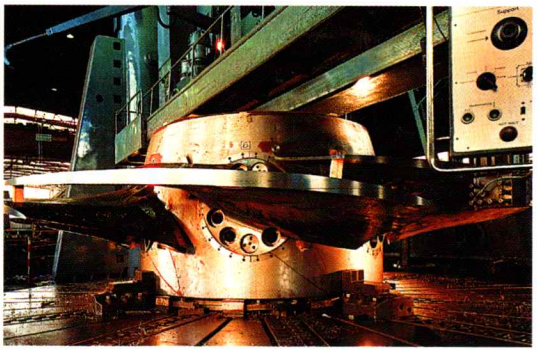
The classic concept from Austria

With the invention of the Kaplan turbine by the Austrian Victor Kaplan the base for a new turbine technology was founded, which is reputed as classic today. The concept is feasible within a head range of 10 to 80 m. Runners with 3 to 8 blades cover the whole range. VA TECH HYDRO has experience in runner diameters up to 9,500 mm and outputs up to 200 MW.



Kainji, Nigeria

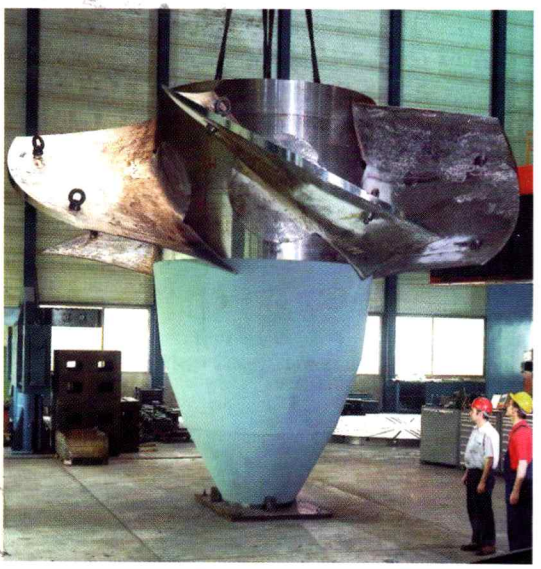
The Kainji Hydroelectric power station is one of the key stations for electricity supply in Nigeria. VA TECH HYDRO has supplied the double regulated Kaplan units No.11 and 12 in 1972. Two years later we were awarded the contract to supply No. 5 and 6 as single regulated propeller type turbines. All units have a full plate steel spiral casing.



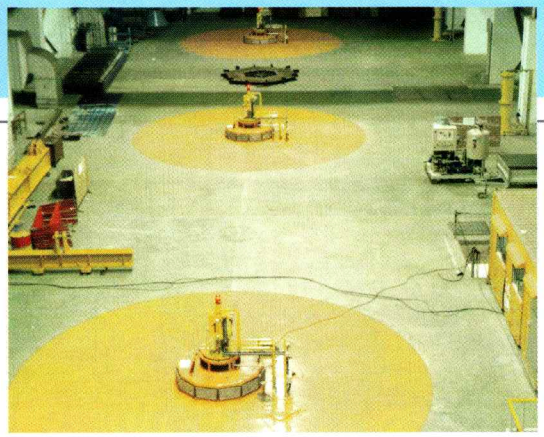
Technical data:	11/12	5/6	
Output:	2 x 108.1 / 2 x 128.7		MW
Head:		38.1	m
Speed:	108.1 /	128.7	rpm
Runner diameter:	6,500 /	6,800	mm

Jebba Dam, Nigeria

Jebba is one of the largest vertical Kaplan power plants in Africa. The contract for VA TECH HYDRO was awarded in 1978 for six units. Manufacturing of all main components was carried out in the workshop of Ravensburg, Germany.



Technical data:		
Output:	6 x 103	MW
Head:	29	m
Speed:	93.8	rpm
Runner diameter:	7,100	mm



Kotapanjang, Indonesia

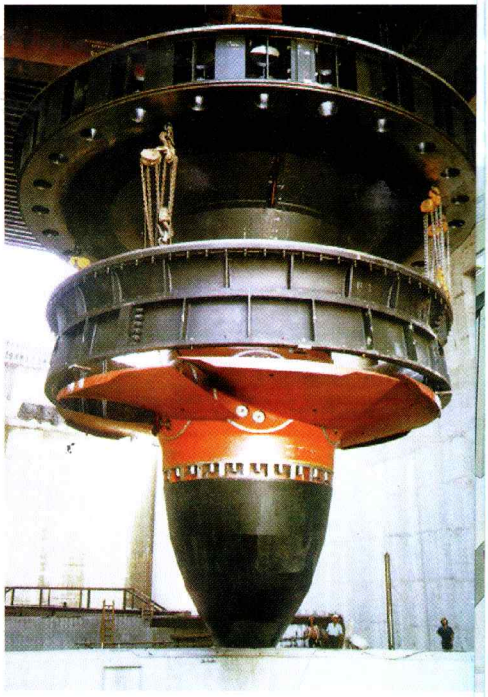
A power plant in the Riau- province in Central Sumatra, Indonesia for PT. PLN (Persero) VA TECH HYDRO supplied vertical shaft generators, main transformers, generator switchgear and Balance of plant equipment (excitation, protection, control, fire fighting equipment, AC and DC station

service system, telecommunication and grounding equipment). Also included in our scope was the design, manufacturing, transportation, installation, commissioning as well as training of the operation staff. On November 21st, 1998, all three units were put into successful commercial operation.

Technical data:		
Output:	3 x 45	MVA
Voltage:	11.0	kV
Speed:	200	rpm
Stator:	6,900	mm

Iron Gate I, Romania

The Iron Gate I hydropower plant is located on the Romanian/Serbian border and features 12,178 MW vertical Kaplan turbines with a runner diameter of 9.5 m, the largest power station in Europe. VA TECH HYDRO is delivering new Kaplan turbine runners of improved design and related electrical and mechanical equipment with an overall output increase of 132 MW for 6 units.
VA TECH HYDRO has been intensively involved in the Iron Gate project since 1993 within team partnerships in Romania and Europe to search for optimized methods to modernize the power plant.
In August 1997, the Romanian government and CONEL (The Romanian Electricity Company) commenced the modernization works, for which VA TECH HYDRO provides comprehensive support and services in all aspects of the refurbishment ranging from project financing, design coordination, supply of turbine runners and related equipment as well as realization of complete automation and control system on a Water-to-Wire basis.

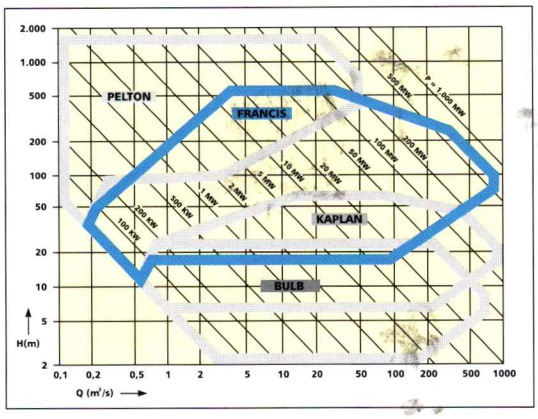


Technical data:		
Output:	6 x 200	MW
Head:	26.5	m
Speed:	71.43	rpm
Runner diameter:	9,500	mm

FRANCIS

Strong in the middle head range

This type of turbine utilizes the widest range of application as far as head and output is concerned; heads of 20 m up to 700 m and outputs up to 700 MW can be covered by Francis type turbines today. The VA TECH HYDRO experience includes heads up to 700 m, runner diameters up to 8,000 mm and outputs up to 450 MW.



Karakaya, Turkey

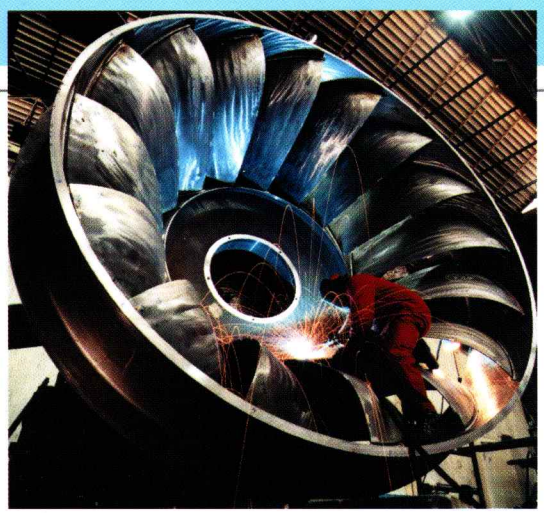
Karakaya, the second stage in the chain of Euphrates power stations, is located in a mountainous region in a rocky gorge about 105 km from the town of Diyabakir. The name of Karakaya means Black Rock

– which dominates the site. The extremely restricted topographical conditions made it necessary to integrate the powerhouse into the foot of the dam.The scope of supply included six Francis turbines equipped with electronic speed governors and six biplane butterfly shutoff valves with a nominal diameter of 5,700 mm.

Technical data:		
Output:	6 x 340	MW
Head:	156.7	m
Speed:	150	rpm
Runner diameter:	5,150	mm

Cirata, Indonesia

The Cirata project is located in West Java, about 90 km southeast of Jakarta and is one of the largest underground hydro-electric power stations.

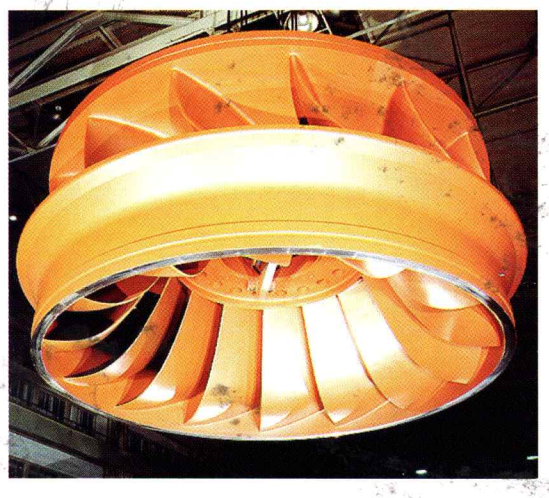


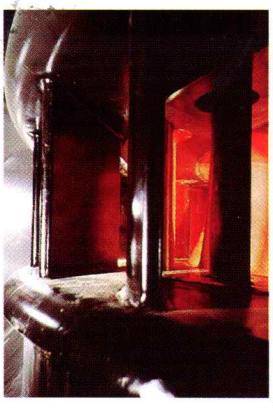
In two stages, 1985 and 1997/98, a total of eight vertical Francis turbines and generators were installed and commissioned. Beside the generating units VA TECH HYDRO supplied the tunnel liners, gates and butterfly valves, the 16.5 kV-equipment, main transformers, 500 kV switchgear and Balance of plant. The last two units were taken over by the client in April 1998.

Technical data:		
Output:	8 x 130 MW / 140	MVA
Head:	106.8	m
Voltage:	16.5	kV
Speed:	187.5	rpm
Runner diameter:	3,400	mm
Stator diameter:	9,800	mm

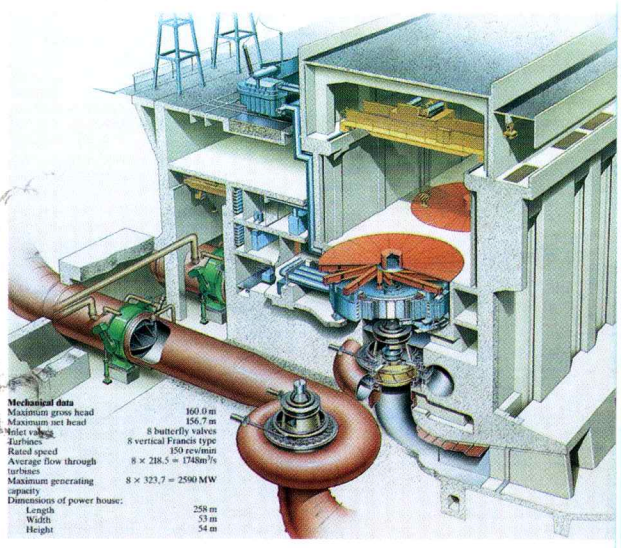
Atatürk, Turkey

Atatürk, the largest hydro station in the Middle East is part of the hydroelectric power scheme on the upper Euphrates in South East Anatolia. Following Keban and Karakaya this is the third and largest power station on the Euphrates with a generating capacity of 2,590 MW and contributes about 8 billion kWh to Turkey's electrical energy requirements.
At the same time it provides irrigation for enhanced agricultural utilization of more than 8,000 km² of land.





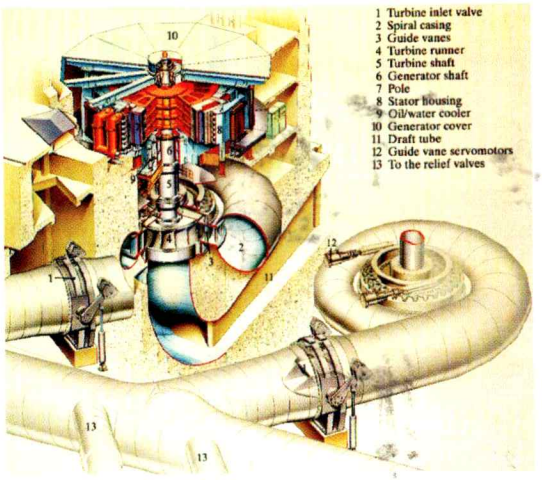
The electromechanical equipment was designed, supplied and installed by a Swiss-German Consortium.
The scope of supply includes eight Francis turbines equipped with electronic speed governors and eight biplane butterfly shutoff valves with a nominal diameter of 5,700 mm.


Mechanical data
Maximum gross head 160.0 m
Maximum net head 156.7 m
Inlet valves 8 butterfly valves
Turbines 8 vertical Francis type
Rated speed 150 rev/min
Average flow through turbines 8 × 218.5 = 1748m³/s
Maximum generating capacity 8 × 323.7 = 2590 MW
Dimensions of power house:
Length 258 m
Width 53 m
Height 54 m

Technical data:		
Output:	8 x 323.7	MW
Head:	156.7	m
Speed:	150	rpm
Runner diameter:	5,150	mm

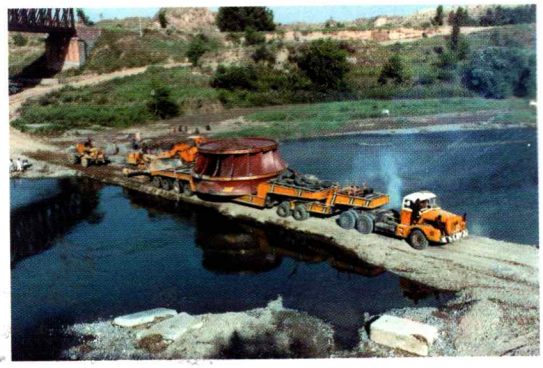
Tarbela 11-14, Pakistan

The Tarbela project, located some 70 km to the north-west of Islamabad, forms part of the Indus Basin Settlement scheme. Between 1977 and 1985 10 Francis units with a generating capacity of 1,750 MW (10 x 175 MW) were installed.
The third Tarbela extension comprises units 11 to 14, which are installed in a new powerhouse.



The extension has some unique features: the largest penstocks in the world, large machine units, wide operating range over which the turbines have to operate (49.4 to 135.6 m) and a sophisticated plant monitoring system (PMS), which monitors the penstocks and tunnel protection, controls the units and maximizes the efficiency of each unit. The transient parameters are measured, processed and monitored and trend analyses is carried out.

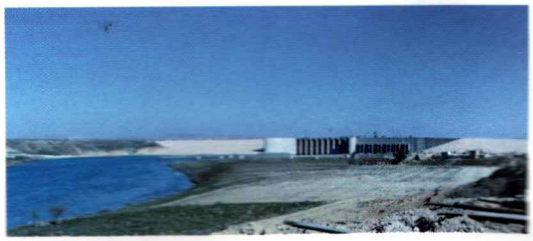
The scope of supply included the four Francis turbines including governors and the plant monitoring system.



Technical data:		
Output:	4 x 444.62	MW
Head:	135.64	m
Speed:	90.9	rpm
Runner diameter:	7,900	mm

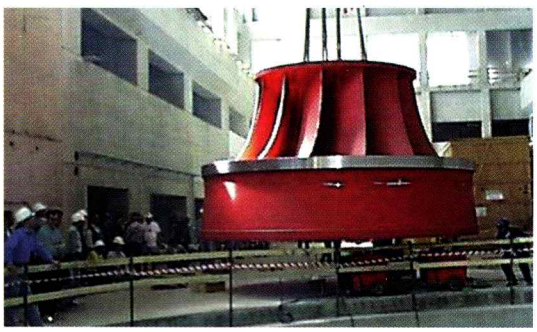
Birecik, Turkey

Birecik dam and plant is located 8 km upstream of Birecik village of Sanliurfa province in Southeast Anatolia on the Euphrates river.
The dam is partly a concrete gravity dam, partly a nip-rap fill dam and has a maximum height of 62.5 m. The power station includes six large units - each having the capacity of 112 MW and the installed capacity reaches a total of 672 MW.



The irrigation of the Gaziantep and Araban meadows of 70,000 ha within the scope of the Southeast Anatolia project shall be done by pumping from Birecik dam. The construction of Birecik dam and plant, for which the Implementation Contract was

signed in March 1993, was completed in October 2001. The operation period is determined to be 15 years starting from the date of commercial operation. At the end of this period the plant based on the first realized BOT scheme in the world shall be transferred to the Ministry of Energy and

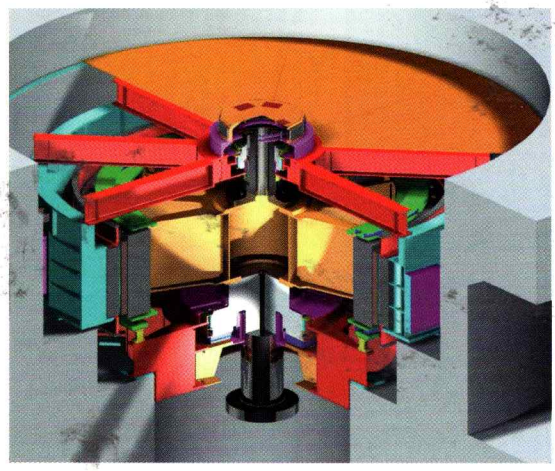


Natural Resources - free of charge.
VA TECH HYDRO is participating in the Birecik A.S. Company which established the investment of more than EURO 1.1 Billion for the survey, finance, construction, production and assembly of the equipment as well as the 15 years operation of the project.

Technical data:		
Output:	6 x 112	MW
Head:	44	m
Speed:	107	rpm
Runner diameter:	5,700	mm

Karun III, Masjed-e-Soleyman, Karkheh, Iran

Having started the business relations with Iran in 1965 with the project Latiyan (2 x 28.5 MVA), VA TECH HYDRO has developed a market share of 56 % in the Iranian Hydro Sector. Large vertical generators of W42-design (upper guide bearing,



lower combined guide-and-thrust bearing) will produce electrical power in the major projects Karun III, Masjed-e-Soleyman and Karkheh.

Technical data: Karun III		
Output:	8 x 300	MVA
Voltage:	15.75	kV
Speed:	187.5	rpm
Stator diameter:	11,500	mm

Technical data: Masjed-e-Soleyman		
Output:	4 x 282	MVA
Voltage:	15.75	kV
Speed:	187.5	rpm
Stator diameter:	11,500	mm

Technical data: Karkheh		
Output:	3 x 160	MVA
Voltage:	13.8	kV
Speed:	150	rpm
Stator diameter:	10,100	mm

PUMPED STORAGE

Power for peak hours

Pumpturbines/motor-generators are the necessary completion of the hydraulic supply program for peak load - and pumped storage power generation. The VA TECH HYDRO experience covers outputs up to 350 MW and units up to the highest heads.

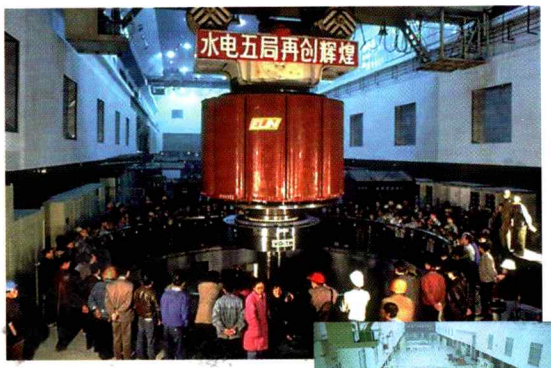
Edolo, Italy

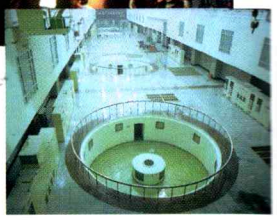
Two vertical 5 stage Francis type pump turbines were commissioned for ENEL S.p.A. Roma, Region Venice in March and June 1984. The scope of supply for VA TECH HYDRO in Schio, Italy was 2 pump turbines with thrust bearing and 4 spherical inlet valves diameter 1,100 mm and pressure 160 bar and auxiliaries.

Technical data:		
Output/Input:	2 x 127 / 132	MW
Head:	1,287	m
Speed:	600	rpm
Runner diameter:	2,200	mm

Shisanling, China

In 1992 one of the largest contracts worldwide was the 4 x 222 MVA Shisanling pumped storage project in China. VA TECH HYDRO supplied all the major electical equipment, especially the motor-



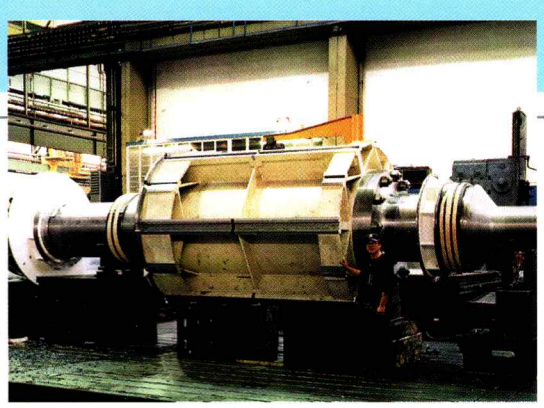


generators including static frequency converter equipment, main transformers, busducts, supervisory control system and complete electrical cubicles. The entire equipment was installed over a two years period, no delays were experienced and the subsequent service history has been excellent.

Technical data:		
Output :	4 x 222	MVA
Voltage:	13,8	kV
Speed:	500	rpm
Stator diameter:	5,320	mm

Tianhuangping, China

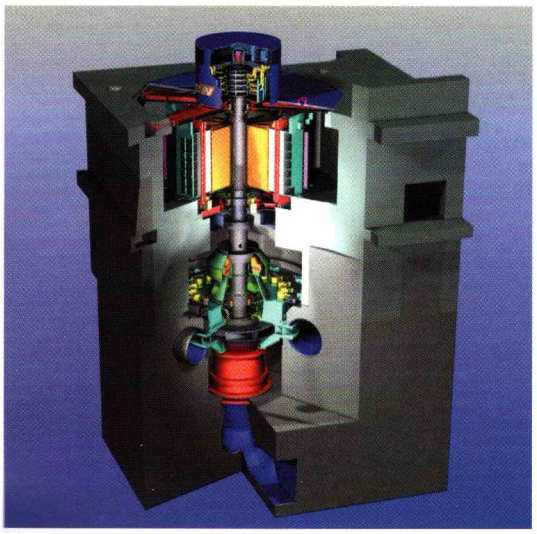
Tianhuangping is one of the largest pumped storage power projects in the world with six reversible pump turbines and motor-generators of a total installed capacity of about 2,000 MW.



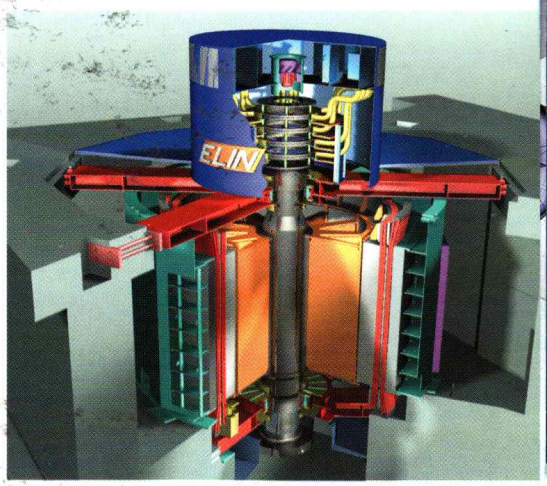
VA TECH HYDRO supplied the motor-generators in cooperation with GE-Hydro, and the Balance of plant equipment such as excitation and protection system, isolated phase busbars, static frequency converters, plant computer and control system, elevators, Diesel generator unit, station service transformers and water measuring systems.

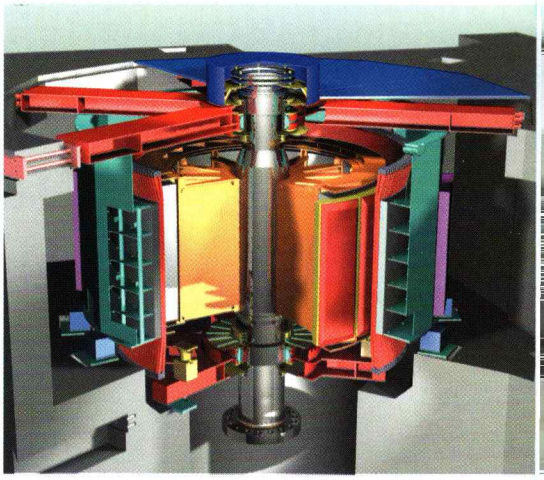
Technical data:		
Output:	6 x 333	MVA
Voltage:	18	kV
Speed:	500	rpm
Stator diameter:	7,700	mm

Goldisthal, Germany



Germany's largest pumped storage power plant will be constructed at Goldisthal in Thuringia. Two motor-generators are designed as conventional synchronous machines with static excitation, while the two other units are double fed asynchronous machines with cyclo-converters for variable speed operation. Besides improved frequency control the variable speed units lead to higher turbine efficiency especially in part load operation and allow active power control in pump mode. For starting in pump operation both, the synchronous speed and the variable speed units are using two static frequency converters.





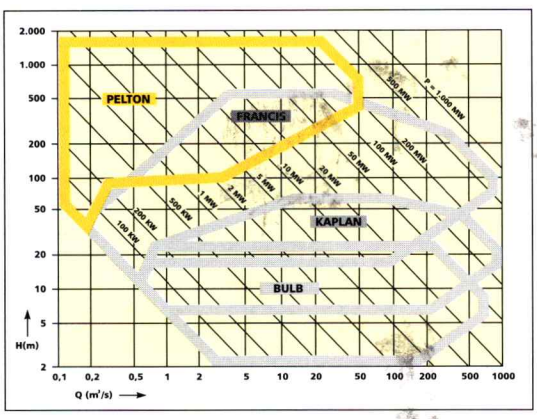
VA TECH HYDRO's scope of supply for the Goldisthal project also includes the four reversible pumpturbines (supplied within a consortium) as well as the entire penstocks and tunnel linings including hydraulic steel structures and DIATECH monitoring systems.

Technical data:		
Motor-Generator:	Synchronous	Asynchronous
Output Turbine:	2 x 308 MW	2 x 264 MW
Output Generator:	2 x 380 MVA	2 x 326 MVA
Input Pump:	2 x 295 MW	2 x 310 MW
Input Motor:	2 x 375 MVA	2 x 350 MVA
Voltage:	18 kV	
Speed:	333.3 rpm	300-346.6 rpm

PELTON

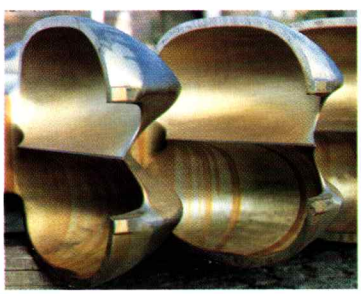
High head turbines up to 1,800 meters head

This turbine concept with horizontal and vertical shaft design utilizes the highest heads up to 1,800 m. One to six jets can cover a wide range of application. The VA TECH HYDRO outstanding references as far as heads up to 1,800 m and unit outputs up to 420 MW are concerned show world records in this turbine type.



Horizontal Pelton Turbines

Oschenik 3, Austria



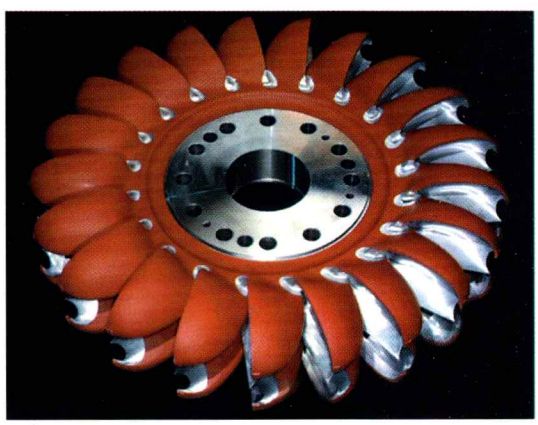
Located in the south of Austria in Carinthia this power-station is a good ex-ample of a high head application with more than 1,000 m head. It forms part of the Austrian peak loadscheme in the central Alps of the "Kärntner Elektrizitätswerke" (Kelag), which includes also the Ausserfragent power-plant, another powerstation using five horizontal shaft double Pelton turbines of VA TECH HYDRO.

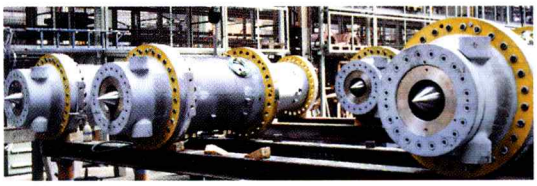
Technical data:		
Output:	42.8	MW
Head:	1,130	m
Voltage:	10,5	kV
Speed:	750	rpm
Runner diameter:	1,825	mm

Vertical Pelton Turbines

Collierville, USA

The Collierville power station with two vertical Pelton turbine/generators, is located at the Stanislaus river in the middle of California.



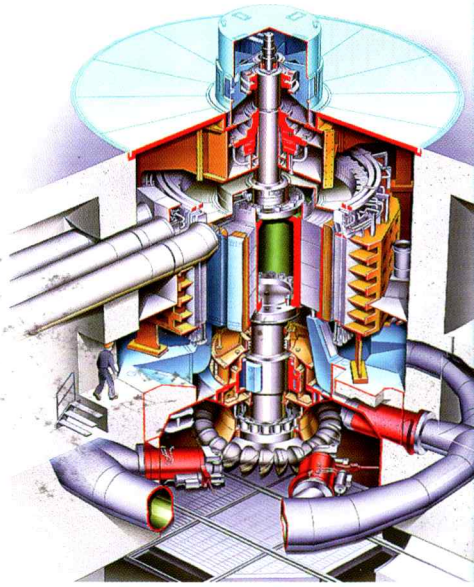


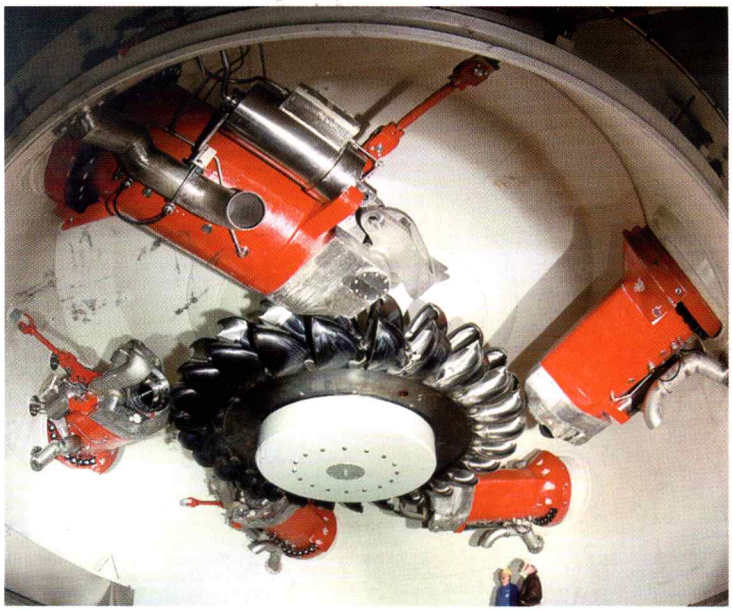
Besides the Pelton turbines and the generators VA TECH HYDRO supplied the complete electrical equipment as well as main transformers, station service transformers, station service and unit auxilliary equipment, generator busbars, switch gears, protection and excitation equipment as well as the entire control and instrumentation of the power stations. The two vertical units were commissioned in 1990.

Technical data:		
Output:	2 x 117 / 140.5	MW/MVA
Head:	685.7	m
Voltage:	13.8	kV
Speed:	450	rpm
Runner diameter:	2,280	mm

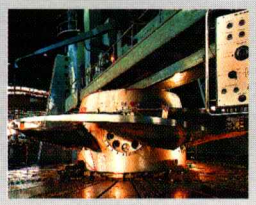
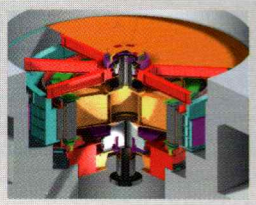
Bieudron, Switzerland

The Grande Dixence hydropower scheme in the Swiss canton of Valais, has been a landmark project in hydraulic engineering since the completion of the record 284 m Grande Dixence gravity dam in 1961, still the world's highest, which stores a volume of 400 million m^3. The fourth extension to the Grande Dixence hydropower scheme – the new station at Bieudron, leaves all previous limits behind: the installed output from each of its three five-jet turbines is not less than 423 MW. The maximum head of 1,869 m also outclasses everything known previously. The scope of VA TECH HYDRO includes model investigation of the runners, design and supply of the five nozzle Pelton turbines with digital speed governors as well as the supply of three spherical valves with a rated diameter of 1,400 mm and design pressure 203 bars and manifolds.

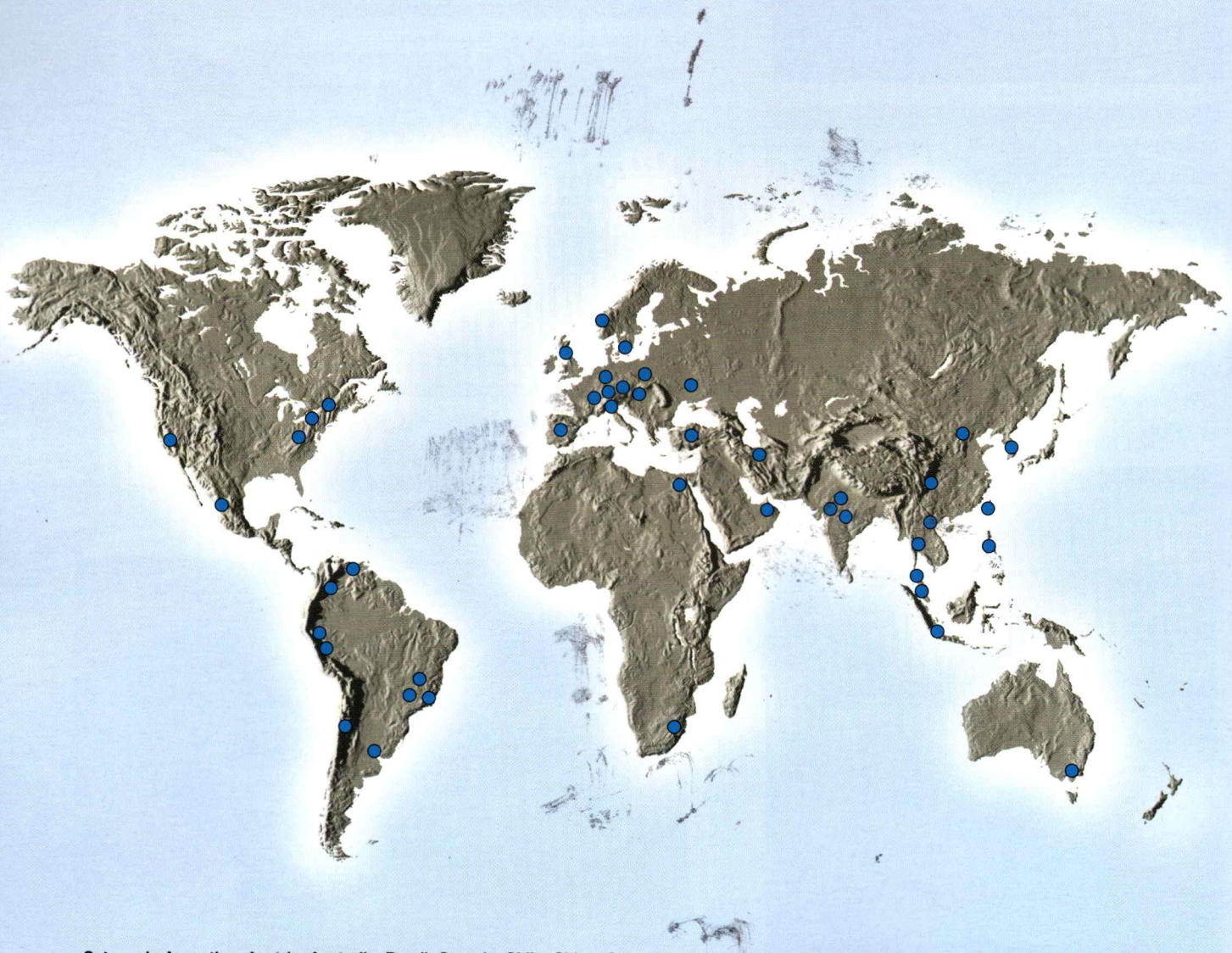




Technical data:		
Output:	3 x 423	MW
Head:	1,869	m
Speed:	428.6	rpm
Runner diameter:	3,993	mm

VA TECH HYDRO worldwide



Set ups in Argentina, Austria, Australia, Brazil, Canada, Chile, China, Columbia, Egypt, France, Germany, Hungary, India, Indonesia, Iran, Italy, Korea, Malaysia, Mexico, Norge, Peru, Philippines, Poland, South-Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Arab Emirates, United Kingdom, Ukraine, USA, Venezuela and Vietnam.

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